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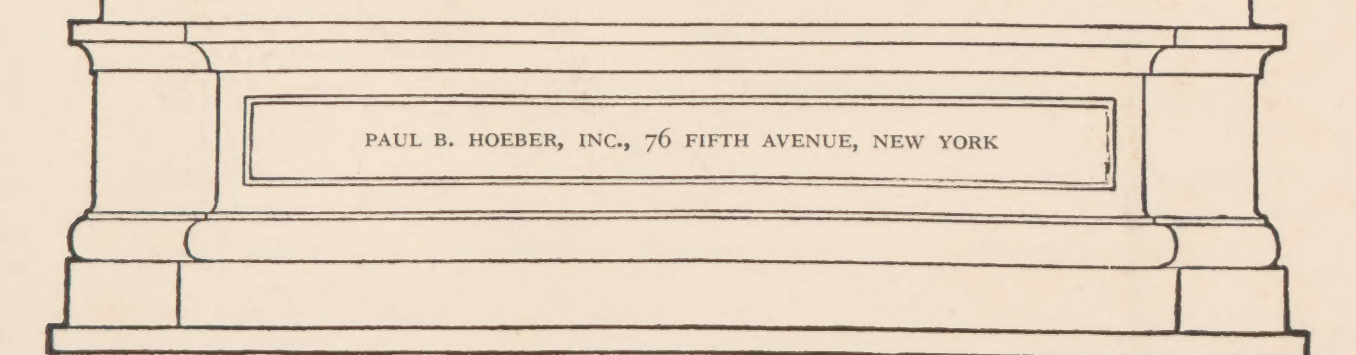
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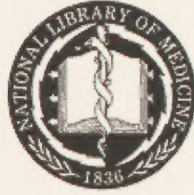
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*Intro*

## SOME LANDMARKS IN THE HISTORY OF LEAD POISONING

By RALPH H. MAJOR

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**P**AUL of Aegina is frequently held up by the medical historian as an example of the low state into which the practitioner of medicine in the seventh century had fallen, because he frequently apologetically disclaimed any originality and because he constantly emphasized that the ancients knew all of medicine that was worth knowing and that he was merely their humble scribe. However, Paul has his good points. Few physicians, ancient or modern, have been so modest as to write seven books of medicine without claiming any originality, and Paul, despite his self-effacing attitude, did make some solid contributions to medical science. In his Third Book of "De re medica," he writes in a very interesting fashion about an epidemic of colic which prevailed in his time.

I consider moreover a colicky affection, which still becomes violent from a kind of collection of humors, which took its origin from regions in Italy, moreover in many other places in Roman territory whence it spread like the contagion of a pestilential plague. Wherefore in many cases it passed into epilepsy, to some there came loss of motion with sensation unhurt, to many both, and of those who fell victims to the epilepsy, very many died. Of those indeed who were paralysed, not a few recovered, for the cause which attacked them ended by crisis.

This description is generally accepted as the first description of lead colic, since our author describes attacks of colic followed by paralysis of the extremities, sometimes with

sensation unimpaired, at other times with involvement of both motion and sensation. So, whatever Paul's shortcomings, he has left us the first account of epidemic lead poisoning that we possess today. This, to be sure, may be only a description of what the Ancients also saw but their accounts have either not been preserved or are not as yet unearthed.

Avicenna, the "Prince of Physicians" some three hundred years, centuries later observed the same species of epidemic colic and wrote that "the paralysis is the crisis of the colic; and to many the sensation remains, and those who recover, recover by paralysis, for nature expels this material and brings it to the exterior."

Neither of these writers, however, expresses the belief that the disease they described was the result of lead. Yet many physicians before Paul were familiar with the effects of lead. Indeed Nikander, who wrote his "Alexipharmaca" in the 2nd century B.C. describes both colic and paralysis as the result of the ingestion of lead. Nikander's verses on cerussa as translated by Euricius Cordus close with:

*Interdum obrepens oritur cum frigore somnus,  
Torpet iners motus, languentia membra  
fathiscunt.*

Sometimes a stealthy stupor comes with a chill

The feeble limbs droop, motion becomes slow,  
then still.

Nikander's verses on litharge were translated by Jacques Grévin de Clermont into quaint sixteenth century



French, in the following spirited passage:

N'ignorez ie te pri', la Litharge mortelle  
Dont la charge se sied dans le ventre, & cruelle  
Fait autour du nombril enfler & tournoyer  
Un grand vent tout bruyant, tel que peut  
essayer

Un homme tourmenté par la douleur cachee  
Que lui est apportant l'incurable trenchee:

This verse is too picturesque to be marred by a translation. Sir John Harrington could probably have turned it into equally quaint Elizabethan English. But the reader with only a passing knowledge of French sees here a striking picture of the poor man who has taken litharge only to be tormented by an intense inward pain and the stirring up of a mass of gas which blows out his navel and causes an incurable colic.

These passages leave no doubt in our minds that Nikander who has been described as the most ancient medical writer after Hippocrates, knew that lead produced both colic and paralysis. He also was familiar with the ocular disturbances of lead poisoning:

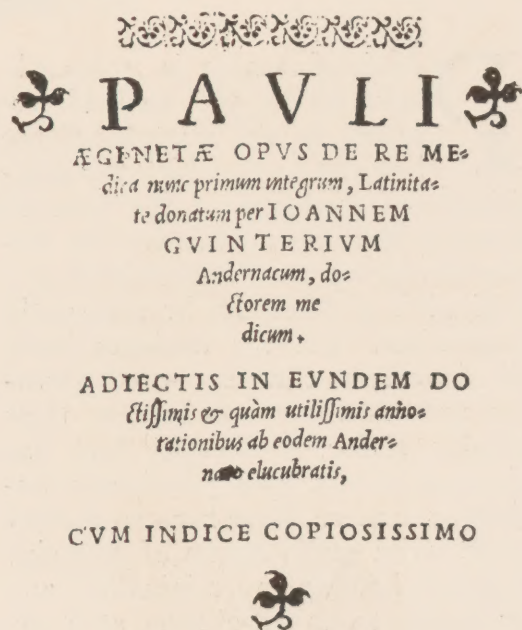
Falso modo ante oculos rerum simulachra videtur.

False images of things only are seen before the eyes.

Indeed Nikander might well be called the poet laureate of lead colic. But this term would fail to do justice to his pharmacological or poetic talents, for he wrote verses not only about lead but about many other poisons. Nikander was praised by Cicero, imitated by Ovid, but Plutarch was unkind enough to say that his works had nothing poetical about them except the meter and that his style was bombastic and obscure.

Many other authorities were also familiar with certain features of lead poisoning. Dioscorides, who is usually

considered the father of materia medica, wrote that cerussa "causes hiccough, cough and dryness of the



Venetis Apud Andream Arriabenum.

M D XXXXII.

FIG. 1. TITLE-PAGE OF PAUL OF AEGINAS "DE RE MEDICA." 1542.

tongue, the extremities become languid, the mind gives way, the limbs are paralysed," and Galen very explicitly warned against drinking water that ran through lead pipes, which caused those who drank it to be subject to intestinal disorders. Vitruvius remarked that "water is much healthier from clay pipes than from lead pipes: since it seems to be poisoned by the lead, for white lead is formed from it: this moreover is said to be harmful to the human body."

Paracelsus, in his works *Das Neudte Buch in der Artzney* ("de Contracturis"), *das ist von krummen und lahmen Gliedern* (the ninth book of therapeutics, "de Contracturis," that is



concerning crooked and lame members) speaks of *Von Ursprung der Contractur die auss der Colica ent-*

**NICANDRI**  
**POETAE ET MEDICIAN-**  
*tiquissimi Theriaca & Alexipharmaca in Latine,*  
*uersus redacta, per EVRICIUM*  
*Cordum, Medicum.*

**IDEM IN EADEM.**

*Contra quosq; suas morsus ictusq; medellae*  
*Nicandrina sacro carmine Musa docet,*  
*Præterquam dire liuentia uulnera lingue,*  
*Illud nulla potest uincere cura malum.*  
*Ergo quis hanc dubitet peiorem dicere pestem,*  
*Quam quæ totus habet cuncta uenena liber.*



**FRANCOFORDIAE Apud Christ-**  
**stianum Egenolphum.**

FIG. 2. TITLE-PAGE OF NIKANDERS "THERIACA & ALEXIPHARMACA." 1532. TRANSLATED BY EURICIUS CORDUS.

*springt an Händen und Füßen ausge-  
 theilt* (concerning the contracture  
 that comes from the colic distributed  
 to the hands and feet). Paracelsus, who  
 as one of his critics remarks "in the  
 midst of the most incomprehensible  
 jargon, sometimes writes intelligibly"  
 evidently in the course of his wander-  
 ings saw and studied lead colic. It  
 has also been pointed out that Para-  
 celsus who was very fond of prescribing  
 lead as a remedy, may have himself  
 caused many of the cases he saw.  
 Indeed this may explain in part the  
 circumstance that when he located in  
 a town and began dispensing his

remedies the people sometimes rose  
 up against him and made things so  
 unpleasant that he was forced to  
 seek another location.

Another physician in those distant  
 times who has left us a good account  
 of a case of lead poisoning was Jean  
 Fernel of Amiens. We remember him  
 as a patriotic Frenchman who, smart-  
 ing with resentment because syphilis  
 was so universally called the *morbus*  
*gallicus* or French disease, insisted  
 that it be called the Disease of  
 Venus or the venereal disease, as  
 Jacques de Béthencourt had suggested.  
 In his treatise "de luis venereae" he  
 records the following history:

A painter of Anjou, thirty years of  
 age, of a good and sound constitution,  
 noticed for the first time in 1557, that  
 his fingers were heavier than usual, that  
 they were numb and difficult to move;  
 after several days he felt them contract  
 and move convulsively, finally the affec-  
 tion was progressively aggravated, until  
 the fingers remained flexed and could not  
 be extended. Moreover, the affection  
 reached the hands and arms, and so by  
 the chilling of the nerves and tendons,  
 filled with a thick humor, they became  
 heavy, trembling and numb. Soon after  
 he experienced the same trouble in his  
 feet, and walking became impossible.  
 However, he had very little pain in his  
 feet, nor in his arms and hands. The poor  
 fellow, as if he had not had already  
 enough ills, saw a symptom appear much  
 more serious and much more painful; for  
 an acute and unbearable pain now  
 attacked his stomach and hypochondrium  
 and extended throughout his abdomen.  
 This pain did not let up during the day  
 or night, it was attempted but in vain  
 to ease it with clysters, hot applications,  
 baths and other remedies.

Fernel attributed the attack to  
 cinnabar, a mercurial pigment which  
 the painter constantly wiped off his



brushes with his fingers. Later authors, however, have seen in this account the description of a typical case of painters' lead colic with paralysis and have pointed out that salivation, which would have occurred had the intoxication been due to mercury, was absent in Fernel's case. So that it was more than probable that the painter from Anjou became ill because he had the failing of wiping off lead paint from his brushes with his fingers. It is also a matter of interest that by a curious coincidence, Fernel describes on the same page of his "*de luis venereae*" the case of a friend of his who took, on the advice of an Empiric, powdered lead for his gout. This friend, after a terrible dysentery, became constipated and suffered from atrocious colics. This case he cites as a warning against the internal use of lead.

Felix Platter, who published the first classification of diseases in 1602, describes colic with paralysis. In his "*Praxeos Medicae*" he speaks of the colic with "atrocious pains & attacked by torments whence they call them *Tormina*, the Germans call them KRI-MEN (gripes).

Noises in the belly & creases, now in one place now running about in several places . . . Constipation attacks many . . . Terrible convulsions & weakness may moreover follow these pains now: which was unknown to most of the ancients, but is frequent in our generation. Now these complications may be general and affect the greater part of the body: now circumscribed they damage only certain parts. Thus impairment of motion has been frequently described.

Platter's description of lead colic is excellent but his explanation is less happy for he blamed it upon a retention of bile.

While there are many other scat-

tered references by physicians to lead colic, it was François Citois who first established its right, as it were, to be



Quod genus inuitæ mortis, lethale venenum  
Contineant in se bestia, & herba, doces.  
Propterea Victor Nicandri nomen adeptus  
Perpetuò extabit: virus at omne fugit.

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FIG. 3. PORTRAIT OF NIKANDER. (COURTESY OF SURGEON GENERAL'S LIBRARY.)

considered a distinct disease, in his *diatriba de novo et populari apud Pictones dolore colico biliaco* which appeared in 1617. In this work, dedicated to his patron, Cardinal Richelieu, Citois described an epidemic of spasmodic colic occurring in the province of Poitou in 1572, and following this publication, we see the disease "colic of Poitou" or *colica pictonum* described with increasing frequency in the medical texts of the time.

Citois described in great detail the disease which he says appeared in the province of Poitou in 1572 and gradually became milder. He notes also that it had been previously observed in Paris and Picardy and moreover in Silesia, Moravia and throughout southern Germany. Citois begins his dissertation with the remark that his century had seen several other new diseases which were the instruments of



God's wrath upon a sinful and unrepentant world, particularly *lues venerea*, *sudor anglicus*, *plica polonica* and



*Fernel*  
*Joannis Fernelius Ambiani*

FIG. 4. JEAN FERNEL—JOANNIS FERNELIUS AMBIANI

the scurvy. And now *colica pictonum* was added to the list.

Citois describes the characteristic colic which seized the patients and gives a particularly graphic account of the palsies. In describing the patients he writes:

... they are seen moving about through the hamlets like ghosts or statues, pale, filthy, thin, with their hands crooked and hanging down from their own weight, they can be moved only with great effort to the mouth or upper parts of the body and not down to the feet but only to the muscles of the thighs. Their gait is ridiculous rather than provoking pity, the voice noisy and rattling.

Following the description of Citois in 1617, the "colic of Poitou" or "bilious colic," as already noted, takes its place in medical literature as a definite syndrome. Sydenham in his "Processus Integri" has a brief chapter, "De colica Pictonum" and writes, "This is a sort of colic, which is wont to degenerate into palsy, depriving the patient of the use both of his hands and feet [a fact noted by Riverius in his chapter on Palsy], and which is extremely common in the West Indies, where it destroys many persons." Thomas Willis wrote of colics with atrocious paroxysms and griping in the belly which were often followed by weakness and paralysis. Sydenham did not speculate as to the causation of the colic. Willis is more bold and explains it with the aid of his favorite theory, *à spiritum animalium defectu*.

Daniel Sennert, who saw and described many things clearly, even though he believed in witchcraft and pacts with the Devil, wrote:

... many widely different places, such as Moravia, Austria, Franconia & many other places have a colic for where strong, sulphuric & tartaric wines are in use it is common & frequently leads to paralysis, arthritis and epilepsy ... Such a colic indeed was widespread in Silesia and in the Duchy of Tuscany in the year 1621.

Wepfer was very familiar with this colic which he ascribed to "wine either excessively sour or fumigated with sulphur and bismuth and mixed with other ingredients and adulterants."

Bernardino Ramazzini in his "De Morbis Artificum Diatriba," the first treatise on occupational diseases, published in 1700, noted that potters who work with lead often show its noxious effects. "For in them," he says, "at first tremors appear in the hands, soon

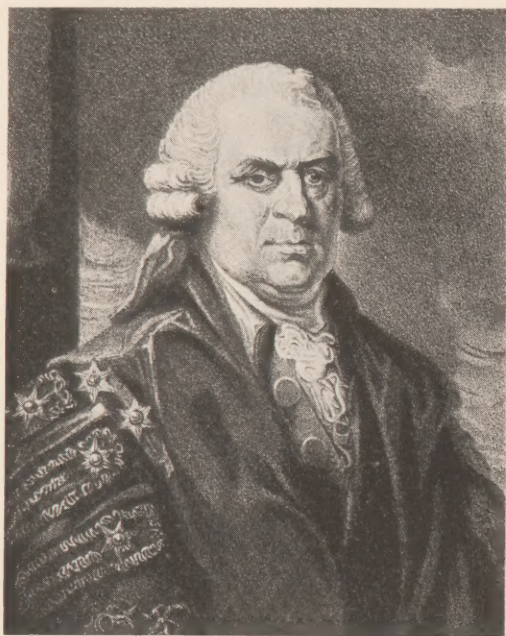


they are paralyzed" and he adds "that rarely anybody sees a potter, in whom the countenance is not cadaverous and leaden."

Sydenham's remark that this colic "is extremely common in the West Indies" shows how widespread the malady was. William Hillary, who went to Barbadoes in 1752 and returned to London in 1758, described the disease in that very interesting book, "Observations on the Changes of the Air and the Concomitant Epidemical Diseases in the Island of Barbadoes," which first appeared in 1759. "This Colic," Hillary observes, "is most commonly called the Dry-gripes, and dry Belly-ache, and is a most painful Disease." He noted that those who "are immoderate Drinkers of spirituous Liquors, especially such as are fiery and new . . . are the most subject to this cruel Disease." He described the "gripping Pains to the Bowels, which are soon after much distended with Wind" and the "Faeces, when they are discharged afterwards, are in little hard dry Lumps like Bullets." He mentions also the "unusual Sensation and Tingling along the spinal Marrow; which soon after extends itself from thence to the Nerves of the Arms and Legs, and they become weak, and that Weakness increases till those extreme Parts become paralytic, with a total Loss of Motion, though a benumbed Sensation often remains."

The dry belly-ache, Hillary saw occasionally while practicing in Bath but neither he nor his colleagues had any clear idea of its cause. For centuries it had tormented its victims. Sennert came very close to discovering the cause and Vicarius described colic and paralysis following the addition of litharge to wine. Indeed the Duke

of Württemberg in 1696 was so impressed with these facts that he issued a decree making it a capital crime to



*G. Baker*

FIG. 5. PORTRAIT OF SIR GEORGE BAKER. (COURTESY OF SURGEON GENERALS LIBRARY.)

add litharge to wine. However, these scattered facts about the colic of Poitiers were either unheeded warnings or lacking conviction. The mystery was finally cleared up by the well-known investigations of Baker on Devonshire colic.

Devonshire colic had probably been endemic for centuries. William Musgrave in 1703 wrote:

. . . indeed there is another colic, in Devonshire, caused by the excessive use of cider crude and acid; it indeed comes from this, it infests only those, who are in the habit of drinking it, and moreover for this reason are affected: since during those seasons when the cider is abundant it spreads among the people; on the contrary when the apples are not abundant it is rarely seen. [He mentions a



gentleman who had what they call the colica pictonum ending in paralysis] the joints then were weak, thin, without motion.

Dr. Huxham who is perhaps best known for his "Essay on Fevers" gave a very accurate account of the Devonshire colic as he saw it.

In the beginning of the autumn 1724, a season particularly remarkable for an abundance of apples, it spread itself all over the county of Devon, among the populace especially, and those who were not very elegant and careful in their diet; and that, though it may not rage with the same degree of violence, and may affect a vastly less number of people, yet it infests that county more or less every autumn.

Huxham describes the colicky pains and paralysis in a vivid way. He also notes that apples were so abundant they were thrown to the hogs. "But the swine-hogs, as well as the swine-men, suffered from the gluttonous abuse of the apples; and all of them wasted greatly in their flesh, and many died." Huxham expressed his conviction that the Devonshire colic was due to the tartar, extracted from the apples in the process of making cider.

Huxham's explanation however failed to satisfy one doctor at least and a little over twenty-five years later Baker began his remarkable studies. George Baker was the son of the Vicar of Modbury, Devon, where he was born in 1722. He was educated at Eton and Kings College, Cambridge, taking his M.D. degree in 1756. He first began practice at Stamford in Lincolnshire but removed to London in 1761. He rapidly acquired a large practice, became physician to Her Majesty's household, and was created a baronet in 1776.

He was nine times president of the College of Physicians. On June 29, 1767, he read his famous paper, "An Inquiry concerning the cause of the Endemial Colic of Devonshire," before the College of Physicians.

Baker is mentioned in "The Gold-Headed Cane" as a friend of its fourth owner, William Pitcairn, and described as "that profound and elegant scholar."

To him the whole medical world looked up with respect, and in the treatment of any disease in the least degree unusual, if it was desired to know all that had ever been said or written on the subject, from the most remote antiquity, down to the case in question, a consultation was proposed with Sir George Baker. From *his* erudition everything was expected.

Baker's erudition and his familiarity with the medical literature of the past, probably suggested to him the similarity between *colica Pictonum*, Devonshire colic and Nikander's description of the effects of lead.

Baker was doubtless more or less familiar from his childhood with Devonshire colic. Although only two years old at the time of the great epidemic which Huxham described, yet he doubtless saw succeeding epidemics, and in later life, after becoming a physician, he developed an especial interest in this disease. Baker's keen mind saw an analogy between lead colic and Devonshire colic and he studied Huxham's account closely. "For although" he said "I always pay that deference, which is due, to the authority of this celebrated physician, I have for some time conceived doubts concerning the solidity of his doctrine" (that Devonshire colic was due to the tartar of cider).

Baker first assembled some inter-



esting data. He found that in the county of Kent a certain gentleman who thought his cider was too sour boiled it with honey in a brewing-vessel, capped with lead. All who drank of it were seized with Devonshire colic. He also learned that in the parish of Bury Pomeroy the cider as soon as made was stored in a large leaden cistern. Those "who drank the cider, thus prepared, were most cruelly tormented by the Devonshire colic: and that many died." He was also much impressed by the fact that while the cider of Devonshire produced colic, the cider of Herefordshire produced no such effects.

Baker finally proved his thesis conclusively by demonstrating that the cider of Devonshire contained lead while that of Herefordshire did not. He showed further that in Devonshire it was a common practice to line the cider-presses with lead.

Baker's investigations created a great storm. He was denounced as a "faithless son of Devon"; the lead he found in his experiments, came, it was asserted, from some shot which were used to cleanse the bottles and which had accidentally been left in them. The colic, it was loudly proclaimed by his opponents, was due to the humors of the body. This second objection he did not deem worthy of an answer, but the first one he demolished by pouring the cider through a cloth that would not allow shot to pass through and then demonstrating lead in the cider.

Still the storm raged. To one of his opponents, he wrote, "I here appeal to the conscience of one person, in particular, whose zeal has induced him to oppose my opinion in print, whether it be not true, that he has for

many years sold sugar of lead to the farmers for the purpose of correcting sour cider." And Baker closes by saying that it seems most probable that lead is the cause of the disease. "In this opinion, however, I may have erred; but I shall be happy even in my error, if it shall excite some more successful inquirer to investigate, and to discover a truth of so much real importance to human society."

But the proof was complete. Lead was removed from the cider presses in Devon and Devonshire colic became a matter of history. Confirmations of Baker's views came from various parts of the world. It was found that in the West Indies, rum was distilled through pewter worms and the pewter contained a considerable quantity of lead. So the dry belly-ache that Hillary saw was caused by lead in the rum.

Two other very important observations in lead poisoning were made later. In 1834 Henry Burton examining patients in St. Thomas Hospital, London, noted an important diagnostic sign of lead poisoning.

In a total number of fifty patients, [he wrote], who were examined whilst under the influence of lead, a peculiar discoloration was observed on their gums, which I could not discern on the gums of several hundred patients, who were not under the influence of lead . . . The edges of the gums attached to the necks of two or more teeth of either jaw, were distinctly bordered by a narrow leaden-blue line, about one twentieth of an inch in width, whilst the substance of the gum apparently retained its ordinary colour and condition.

Nothing further of importance was added to existing knowledge of lead poisoning for over sixty years. Then in 1900, Hamel, working in Grawitz'



clinic, studied 25 cases of lead poisoning and found in all but 2, basophilic granules in the red blood cells, the same granules that Grawitz had described the previous year, in severe anemias. This observation was soon confirmed by numerous investigators and its great importance in the diagnosis of lead poisoning established.

Epidemics of lead colic, once so frequent, are now practically unknown. Their disappearance has been due to Baker's demonstration that "Devonshire colic" and *colica pictorum* were nothing other than lead poisoning. The world has long since forgotten that Baker was physician to Queen Charlotte or nine times president of the College of Physicians. His elegant and learned writings on epidemic catarrh and epidemic dysentery are known only to the medical antiquarian but his "Inquiry concerning the cause of the Endemial Colic of Devonshire" remains a medi-

cal classic, a model of clear accurate thinking, careful experimentation and lucid presentation.

Sporadic cases of lead poisoning still occur, but they are usually recognized easily by the demonstration of a lead line on the gums and of basophilic granulations in the red blood cells. Indeed, the presence of a lead line and basophilic granulations have saved many a patient with the tentative diagnosis of intestinal obstruction from an unnecessary surgical operation. The observations of Burton and of Hamel were thus also of tremendous importance and they may be rightly considered as ranking with the other landmarks in the history of lead poisoning.

The words written in italics: i.e. *colica pictorum*, appear in the original in italics; words written with small capitals below: as, KRIMEN and DAS NEUDTE BUCH IN DER ARTZNEY, are written in the original in Gothic type.

## REFERENCES

1. PAULI AEGINETAЕ. Opus de Re Medica nunc primum intergrum Latinitate donatum per Ioannem Guinterium. Venetijs apud Andream Arrivaneum, MDXXXII.
2. AVICENNA. Quoted by Baker.
3. NICANDRI. Poetae et Medici antiquissimi: Theriaca & Alexipharmaca in Latinos versus redacta, per Euricium Cordum, Medicum. Francofordiae Apud Christianum Egenolphum, Anno MDXXXII.
4. Les oeuvres de Nicandre traduites en vers francais par Jacques Grévin de Clermont en Beauvaisis. Anvers. C. Plantin, 1567.
5. NICANDER. Alexipharmaca. Jo. Gorreaeo. interprete. Parisiis apud Vascosanum, 1549.
6. DIOSCORIDIS. Libri Octo graece et Latine. Parisii Apud Petrum Haultinum 1549.
7. Der Buecher und Schrifftten des Edlen Hochgelehrten und Bewehrten Philosophi unnd Medici Philippi Theophrasti Bombast von Hohenheim Paracelsi genannt. Erster Theil. Franckfort am Meyn. Joh. Wechels Erben, Anno MDCIII.
8. IOANNIS FERNELII AMBIANI. Therapeutices Universalis. Francfurti Apud Andream Wechelum, MDLXXXI.
9. FELICIS PLATERI, quondam Archiatri et Profess. Basil. Ord: Praxeos Medicae. Basilae, Impensis Emanuelis König, MDCLVI.
10. CITOIS. Quoted by Baker.
11. THOMAE SYDENHAM, Medic doct. Opera Omnia Medica. Patavii, Typis Seminarii, MDCCXXV.
12. THOMAE WILLIS. Opera Omnia Caloniae MDCXCIV. De Anima Brutorum Pathologici, Caput XV, De Passione Colica.
13. DANIELIS SENNERTI, Vratislaviensis, D. & Medicinae in Acadamia. Wittebergensi Profess. P. Medicinae Practicae. P. 594. Venetiis MDCL. Apud Iuntas & Hertz.



14. WEPFER, JOH. JACOBI. *Historiae apoplecticorum*. Amstelaedami apud Janssonio-Waebergias, MDCCXXIV.
15. RAMAZZINI, BERNARDINI. *Opera Omnia*. Genevae, Cramer & Perachon, 1716.
16. HILLARY, W. *Observations on the Changes of the Air and the Concomitant Epidemical Diseases in the Island of Barbadoes*. London, 1766.
17. MUSGRAVE, G. *De arthritide symptomica*. Oxoniae, 1703.
18. HUXHAM, J. *Opusculum de Morbo Colico Damnoniensi*. Londini, J. Hinton, 1752.
19. BAKER, G. *An inquiry concerning the Cause of the Endemial Colic of Devonshire*. *Med. Trans.* London, 1: 175, 1772.
20. BURTON, H. *On a remarkable effect upon the human gums produced by the absorption of lead*. *Med. Chir. Trans.*, London, 23: 63, 1840.
21. HAMEL. *Ueber die Beziehungen der körnigen Degenerationen der rothen Blutkörperchen zu den sonstigen morphologischen Veränderungen des Blutes mit besonderer Berücksichtigung der Bleiintoxication*. *Deutsch. Arch. f. klin. Med.*, 67: 357, 1900.

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